(19) Korean Intellectual Property Office (KR)
(12) Published Patent Application (A)

(51) Int. Cl. 6
G01D 5/36

(11) Publication No. P-2000-0066245
(43) Publication Date: Nov. 15, 2000

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(21) Application No.: 10-1999-0013202
(22) Application Date: April 14, 1999
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Request for Substantive Examination: Yes

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(54) A REVOLUTION COUNTER FOR A NUMBER WHEEL IN A METER

(Abstract)

Disclosed is a revolution counter for a number wheel in a meter, in which data on the amount of use of supplies can be obtained by counting the revolution number of the number wheel. A reflective tape is affixed to the circumferential face of the number wheel. A pulse generator produces a sequence of pulse signals, and a rotation detector generates an incident light using the sequence of pulse signal as an actuating electric power and converts the reflected light reflected by the reflective tape into an output pulse signal. A revolution counter unit constituted of a microcomputer or a central processing unit determines the revolution number of the number wheel having the reflective tape affixed thereto by detecting whether there occurs a rapid change in the generation interval of the output pulse signal. The data as obtained above can be utilized in a remote-reading system. The actuating signal is provided in the form of pulse, so that the energy consumption can be reduced.

Representative Drawing
FIG. 3

(Specification)

(Brief Description of the Drawings)

FIG. 1 shows an installed state of a revolution counter according to the invention;

FIG. 2 shows the number wheels of a meter, in which a reflective tape is affixed to the lowest-digit number wheel;

FIG. 3 illustrates the construction of a first embodiment of the invention;

FIG. 4 illustrates the construction of a second embodiment of the invention;

FIG. 5a is a diagram showing the wafeform of an input pulse from the light emitter;

FIGS. 5b to 5d are a diagram showing the output waveform of the light sensor.

** Description of Major Components in the Drawings**

10: Meter	20: Transparent plate
30: Number wheel	30a: Lowest-digit number wheel
40: Reflective tape	100: Pulse generator

110: Light emitter | 120: Light sensor
130A, 130B: Amplifier | 140A, 140B: Microcomputer
200: Light blocking member

(Detailed Description of the Invention)

(Object of the Invention)

(Field and Background of the Invention)

The present invention relates to a remote-reading system of a meter. More specifically, the invention relates to a revolution counter for a number wheel in a meter, in which the revolution number of a particular number wheel can be detected so that an electrical signal corresponding to the amount of use of supplies can be generated.

Electricity, gas or water provider charges a fee in proportion with the consumption of the supplies. The provider must read periodically the meter to determine the amount of consumption of supplies for each customer. The amount of consumption can be determined by reading directly the numbers displayed by the number wheels in the meter.

However, the direct reading of each meter requires a lot of efforts and time. Mostly the meter is installed inside the customer's house. Therefore, a meterman of the provider must enter the customer's house to directly read the meter, or may be informed of the reading from the customer, outside of the house without entering the house. If the customer is absent, the meterman must visit the customer's house repeatedly, which leads to an inconvenience and further an annoyance for the meterman. One solution for this inconvenience is that the customer reads the meter and records the readings somewhere outside the house. However, this approach needs the customer's cooperation, and regular inspections and records are burdensome work for the customer. In case where the customer's cooperation cannot be obtained, the meterman must read the meter directly in any way.

In order to solve the above problems in the art, many attempts have been made recently for a remote-reading system of a meter. These approaches have some problems in that the structure of existing meters must be significantly changed to apply the remote-reading system, and consideration of energy saving is not sufficient, thereby leading to a high consumption of electric power.

(Object of the Invention)

It is an object of the invention to provide a revolution counter for detecting the revolution number of a number wheel in a meter, which rotates in proportion with the amount of supplies consumed.

Another object of the invention is to provide a revolution counter for a number wheel having a low electric energy consumption.

(Construction and Operation of the Invention)

In order to accomplish the above object of the invention, there is provided a revolution counter for a number wheel in a meter, in which an amount of use of supplies is indicated by an accumulative revolution number of plural number wheels, and the revolution number of number wheel is countered to provide information on the amount of used supplies.

According to one embodiment of the invention, the revolution counter for the number wheel comprises: a reflective tape affixed to the circumferential face of at least one number wheel and for reflecting an incident light; a pulse generator for generating a sequence of pulse signals; a rotation detector for generating an incident light using the sequence of pulse signals as

an actuating electric power and for converting a reflected light reflected by the reflective tape into an output pulse signal; and a revolution counter unit for determining the revolution number of the number wheel having the reflective tape affixed thereto by detecting whether there occurs a rapid change in the generation interval of the output pulse signal.

According to another embodiment of the invention, the revolution counter for a number wheel comprises: a reflective tape affixed to the circumferential face of at least one number wheel and for reflecting an incident light; a rotation detector for generating an incident light using a sequence of pulse signals as an actuating electric power and for converting a reflected light reflected by the reflective tape into an output pulse signal; and a revolution counter unit for generating the sequence of pulse signals and providing it to the rotation detector, and determining the revolution number of a number wheel having the reflective tape affixed thereto by detecting whether there occurs a rapid change in the generation interval of the output pulse signal.

The rotation detector is composed of a light blocking member including a bottom and a cover, the bottom and the cover forming a closed space for blocking an external light, the bottom being affixed above the number wheel in such a way not to interrupt the rotation thereof, the bottom having a hole formed therein capable of being closed by the number wheel, the cover having a partition extended from the inner face thereof until near the hole and for dividing the closed space into two sections; a light emitter installed in the inner face of the cover and for radiating the incident light according to the sequence of pulse signals input thereto; and a light sensor installed in the inner face of the cover at a position different from that of the light emitter and for detecting the reflected light reflected by the reflective tape when it closes the hole and outputting the pulse signal.

The revolution counter of the invention may further comprise an amplifier for amplifying the output pulse signal output by the light sensor. In addition, the revolution counter unit includes a microcomputer or a central processing unit, and determines one rotation of the number wheel, based on when the generation interval of pulse signal is increased more than two times thereof or when it is decreased smaller than half times thereof.

The preferred embodiments of the invention will be hereafter described, in detail, with reference to the accompanying drawings.

As shown in FIG. 2, a display unit of the meter 10, to which the invention is applied, comprises plural number wheels 30. Each number wheel corresponds to one digit. In practice, only upper several digits (hereinafter, referred to as a "significant digit") are used to determine an amount of use, and the digits lower than that (hereinafter, referred to as an "unimportant digit") are neglected when calculating the use amount. For example, in case of electricity supply, the electricity provider determines the amount of used electricity in a unit of Kilowatt-hour (Kwh), and thus the digit wheel indicating a value lower than Kilowatt, i.e., decimal digits is not considered when metering the supplied electricity. The actual meter has at least one lower digit number-wheel in order to indicate an accurate amount of use for the water, gas or electricity supplies, which will be hereafter referred to as the "supplies" or "utility." When a customer uses the utility, the number wheels 30 of the customer-side meter 10 rotate at different speeds proportionally with the amount of used supplies. That is, the lowermost digit number-wheel 30a will rotate at the highest speed, and the uppermost digit number-wheel will rotate at the lowest speed. The rotation frequency of a number wheel should be one tenth of that of the one-digit higher number-wheel. In other words, the one-digit higher number wheel will rotate once every ten times of rotation of a one-digit lower number-wheel (i.e., one-digit-right wheel in the meter).

As shown in FIG. 3, a revolution counter of a number wheel in a meter according to a

first embodiment of the invention comprises a reflective tape 40, a pulse generator 100, a rotation detector 110, 120, and 200, an amplifier 130A, and a microcomputer 140A.

The reflective tape 40 is attached to one of the number wheels in the decimal places, rather than above the decimal point, so that the amount of used supplies can be directly confirmed. For example, as shown in FIG. 2, the reflective tape 40 may be attached to an arbitrary position on the circumferential face of the lowest-digit number wheel 30a. The length of the reflective tape is preferred to be from one tenth to one third of the circumference of the lowest-digit number wheel 30a so that the rotation frequency thereof can be detected even in case where an abrupt fluctuation occurs in the amount of use. It is preferable that the reflective tape 40 has a good optical reflectivity and a smooth surface to avoid irregular reflection.

The rotation detector is composed of a light emitter 110, a light sensor 120, and a light blocking member 200. As shown in FIG. 1, the rotation detector is installed right above the number wheel 30a, to which the reflective tape 40 is attached.

The light blocking member 200 includes a bottom 206 and a cover 202 so as to form a closed space where no external light is introduced. The bottom 206 is fixed above the number wheel 30a in such a manner not to interrupt the rotation of the number wheel 30a. That is, as shown in FIG. 3 or 4, the bottom 206 may be affixed to a transparent plate 20 of the meter, or may be fixed above the number wheel 30a after removal of the transparent plate 20. The bottom 206 is provided with a small hole 208 capable of being closed by the number wheel 30a. From the upper end of the inner face of the cover 202, a partition 204 is extended near the hole 208 to thereby divide the closed space of the light blocking member 200.

The light emitter 110 functions to convert an input electric power to light rays. For example, the light emitter may comprise a light emitting diode (LED) emitting a light when an electric current is applied thereto. The light emitter 110 is installed in the inner face of the cover 202 such that it can radiate an incident light through the hole 208 formed in the bottom 206. The light emitter 110 is provided with an actuating signal P_{in} in the form of a pulse from a pulse generator 100. Therefore, the light emitter 110 radiates the incident light intermittently through the hole 208 of the bottom 206.

The light sensor 120 functions to convert the received light into an electric signal and output it. The light sensor 120 is installed in the inner face of the cover and at a position different from that of the light emitter 110 such that, when the hole 208 is closed by the reflective tape 40, it can receive the light reflected on the reflective tape 40 and generate an electrical sensing signal (P_{out}). For example, the light sensor 120 may employ a phototransistor, in which the light received through an associated lens is converted into an amplified current as an output. Here, the sensing signal output by the phototransistor is a signal in the form of a pulse (P_{out}).

The pulse generator 100 may be composed of an oscillator (not shown) generating a pulse signal having a desired magnitude of frequency and a counter (not shown) for demultiflying the pulse signal generated by the oscillator and outputting a pulse signal (P_{in}) having a desired frequency. There is no limitation in the type of the oscillator, and the demultiflying value can be varied when required. FIG. 5a is a diagram showing a waveform of the pulse signal (P_{in}) output from the pulse generator 100. Th pulse signal is supplied to the light emitter 110 as an input signal.

The amplifier 130A is connected to the output terminal of the light sensor 120, amplifies the output signal P_{out} of the light sensor 120, and output the amplified pulse signal P'_{out}. The amplifier 130A may be adopted to amplify the output signal P_{out} when its intensity is not sufficient. Therefore, where the output signal P_{out} of the light sensor 120 has an appropriate intensity required for a subsequent signal processing, the amplifying step can be omitted.

The microcomputer 140A is connected to the output terminal of the amplifier 130A, if it is adopted, and otherwise is connected to the output terminal of the light sensor 120. Instead of the microcomputer, a central processing unit (CPU) may be employed. The microcomputer 140A compares the generation interval of the output pulse P_{out} from the light sensor 120 such that it can determine one rotation of the number wheel 30a by recognizing a sequence of 'non-reflection → reflection → non-reflection' of the reflective tape 40 attached thereto.

FIG 4 shows a revolution counter for a number wheel in a meter according to a second embodiment of the invention, which comprises a reflective tape 40, a rotation detector 110, 120, 200, an amplifier 130B, and a microcomputer 140B. The second embodiment is substantially the same as the first one, except that a pulse generator 100 providing an input signal P_{in} to the light emitter 110 is incorporated into the microcomputer 140B. Therefore, the microcomputer 140B provides a pulse signal P_{in} (shown in FIG 5a) to the light emitter 110 as an input signal thereof using an input/output port or a memory line, and simultaneously functions to determine the rotation frequency of the number wheel 30a using the output pulse P_{out} obtained by light sensing, similar as in the microcomputer 140A of the first embodiment. The method of determining the rotation of the number wheel is identical to that of the first embodiment.

According to the invention, the operation for detecting the rotation frequency of the number wheel 30a is carried out as follows.

The light emitter 110 is continuously supplied with an input pulse P_{in} (shown in FIG 5a) from the pulse generator 100 or the microcomputer 140B, and periodically radiates a pulsed light. The radiated light is radiated toward the number wheel 30a through the hole 208. The period T_{in} of input pulse P_{in} is related to the rotation speed of the number wheel 30a. It is assumed that the ratio of the length of the reflective tape 40 to that of the number wheel 30a is A (where, $0 < A < 1$), and the rotation cycle of the number wheel is B seconds when it rotates with a maximum speed. In order to detect the rotation of the number wheel 30a, the reflective tape 40 must be able to reflect the pulsed light more than two times. Therefore, the period T_{in} of the input pulse P_{in} is determined so as to meet '$Tin > 2AB$'. The width P_d of the input pulse P_{in} may be established such that it is larger than the response speed of the light emitter 110 and the light sensor 120 and also is smaller than the period T_{in}. The response speed of the light emitter 110 and the light sensor 120 is usually a few to a few tens of microseconds.

The light sensor 120 generates a sensing signal P_{out} only when it senses the light of the light emitter 110 reflected by the reflective tape 40, i.e., a reflector. When the reflective tape 40 (hereinafter, referred to as a 'reflector') is not located below the hole 208, the light radiated by the light emitter 110 is mostly absorbed by that portion of the circumferential face of the number wheel where the reflective tape is not attached (hereinafter, referred to as a 'non-reflector'), and partly irregularly reflected, so that the light sensor 120 can not generate a sensing signal P_{out}.

When the customer uses the supplies such as water, electricity or gas, the number wheel 30a of the meter 10 is rotated and thus the reflector is periodically placed below the hole 20 although its period is not constant. That is, the reflector and the non-reflector are alternatingly placed below the hole 208. In case where subsequent to the non-reflector the reflector passes below the hole 208, the output pulse P_{out} of the light sensor 120 leads to a pulsed section after a non-pulsed section, as shown in FIG 5b. On the contrary, when subsequent to the reflector the non-reflector passes below the hole 208, the output pulse P_{out} of the light sensor 120 results in a non-pulsed section after the pulsed section, as shown in FIG 5c. Therefore, in summary, when the sequence of 'reflector → non-reflector → reflector' is occurred below the hole 208, the light sensor 120 generates the output pulse P_{out} in the form of 'pulsed section → non-pulsed section → pulsed section', as shown in FIG 5d.

As understood from FIG. 5d, when the portion placed below the hole 208 is changed into a non-reflector from a reflector, or into a reflector from a non-reflector, there occurs an abrupt increase or decrease in the generation interval of the output pulse P_{out} from the light sensor 120. Therefore, the microcomputer 140A or 140B recognizes the rapid increase or decrease in the pulse interval and counts it as one rotation of the number wheel 30a.

The above operation will be explained in greater detail. The amplified pulse signal P'_{out} from the amplifier 130A, or the output pulse P_{out} directly from the light sensor 120 is input to the microcomputer 140A or 140B, which may recognize these pulse signal P_{out} or P'_{out} in two manners. First, the pulse signal is input through an interrupt port and is recognized while carrying out other operations. Secondly, the pulse signal is input to a data port, and the generation of pulse signal may be recognized by periodically polling the data port. The polling interval is required to be shorter than that of the input pulse P_{in}. In the former case, since the width P_d of the input pulse P_{in} must be longer than the command processing time of the microcomputer 140A (usually a processing time for three commands), the width P_d of the input pulse P_{in} is larger than that of the second case. The microcomputer 140A or 140B continuously checks the time interval for the generation of the pulsed signal P_{out} or amplified pulsed signal P'_{out} and compares the gap between the pulses, i.e., the gap between the current time interval and the previous time interval with a reference value. As the result of comparison, if the microcomputer recognizes the sequence of 'non-refection → reflection → non-reflection', it counts one rotation of the number wheel 30a having the reflection tape 40 attached thereto. The reference value as to how rapid or abrupt the change in the generation interval of output pulse P_{out} is to be counted as one rotation is determined, considering the length of the reflective tape 40, the period of input pulse P_{in} input to the light emitter 110, and the rotation period of the number wheel 30a. Usually, two or more times of increase, or more than half of decrease in the generation interval of output pulse P_{out} may base the recognition of one rotation. Considering the case where the amount of use is abruptly changed, the following two matters are required to be considered. As previously described, the length of the reflective tape attached to the number wheel 30a must be one tenth to one third of the circumference of the wheel 30a. Also, the generation interval for recognizing one rotation must be set to a value larger than two times or smaller than half thereof.

When the supplies are not used, the number wheel is not rotated, and thus the reflector or the non-reflector will be placed under the hole 208 and cover it. In this case, a pulsed section or a non-pulsed section will be continuously led. Therefore, there does not occur a rapid or abrupt change in the generation interval of the output pulse P_{out}, so that the microcomputer 140A or 140B recognizes that the number wheel 30a does not rotate.

(Effects of the Invention)

The sensing signal obtained from the rotation detector may be applied in various ways. For example, if the sensing signal is directly transmitted to the provider's computer system, the meter-reading work by a meterman can be omitted. As another example, the sensing signal can be transmitted to the remotely-installed counter, for example, installed in an entrance of a multifamily housing or an apartment building, and the counted value, i.e. the amount of consumed utility for each family or each house can be displayed in a display device such as an LCD. Therefore, a meterman can carry out expeditiously and conveniently the meter-reading work, without necessity of visiting every house in person.

In addition, the rotation detector can be simply installed in the already-established meters, without any replacement of parts or change in their structures, which leads to an

economical practice of the invention.

Furthermore, since the input signal actuating the light emitter is provided in the form of pulse, the energy consumption is very low, thereby reducing the operation cost, as compared with the conventional remote-reading system.

While the present invention has been described with reference to several preferred embodiments, the description is illustrative of the invention and is not to be construed as limiting the invention. Various modifications and variations may occur to those skilled in the art without departing from the scope and spirit of the invention as defined by the appended claims.

(57) Claims:

1. A revolution sensor in a meter, in which an amount of used supplies is indicated by an accumulative revolution number of plural number wheels, the rotation detector comprising:

a reflective tape affixed to the circumferential face of at least one number wheel and for reflecting an incident light;

a pulse generator for generating a sequence of pulse signals;

a rotation detector for generating an incident light using the sequence of pulse signals as an actuating electric power and for converting a reflected light reflected by the reflective tape into an output pulse signal; and

a revolution counter unit for determining the revolution number of the number wheel having the reflective tape affixed thereto by detecting whether there occurs a rapid change in the generation interval of the output pulse signal.

2. A revolution sensor in a meter, in which an amount of use of supplies is indicated by an accumulative revolution number of plural number wheels, the meter comprising:

a reflective tape affixed to the circumferential face of at least one number wheel and for reflecting an incident light;

a rotation detector for generating an incident light using a sequence of pulse signals as an actuating electric power and for converting a reflected light reflected by the reflective tape into an output pulse signal; and

a revolution counter unit for generating the sequence of pulse signals and providing it to the rotation detector, and determining the revolution number of a number wheel having the reflective tape affixed thereto by detecting whether there occurs a rapid change in the generation interval of the output pulse signal.

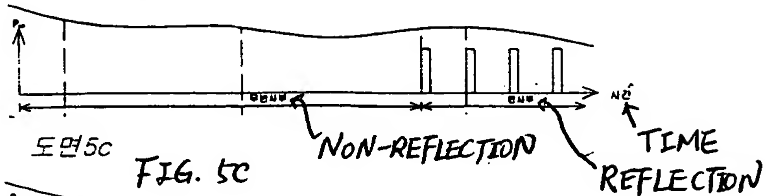
3. A revolution sensor according to claim 1 or 2, wherein the rotation detector is composed of a light blocking member including a bottom and a cover, the bottom and the cover forming a closed space for blocking an external light, the bottom being affixed above the number wheel in such a way not to interrupt the rotation thereof, the bottom having a hole formed therein capable of being closed by the number wheel, the cover having a partition extended from the inner face thereof until near the hole and for dividing the closed space into two sections; a light emitter installed in the inner face of the cover and for radiating the incident light according to the sequence of pulse signals input thereto; and a light sensor installed in the inner face of the cover at a position different from that of the light emitter and for detecting the reflected light reflected by the reflective tape when it closes the hole and outputting the pulse signal.

4. A revolution sensor according to claim 1 or 3, further comprising an amplifier for amplifying the output pulse signal output by the light sensor.

5. A revolution sensor according to claim 1 or 3, wherein the revolution counter includes a microcomputer or a central processing unit.

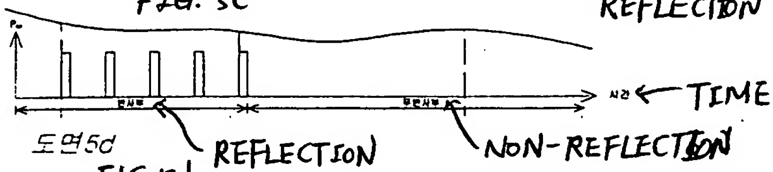
6. A revolution sensor according to claim 1 or 3, wherein the revolution counter determines one rotation of the number wheel, based on when the generation interval of pulse signal is increased more than two times thereof or when it is decreased smaller than half times thereof.

FIG. 5b



도면5c

FIG. 5c



도면5d

FIG. 5d

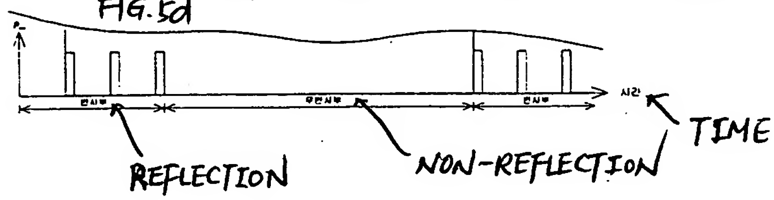
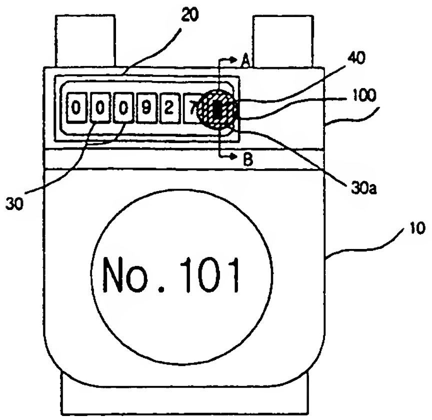
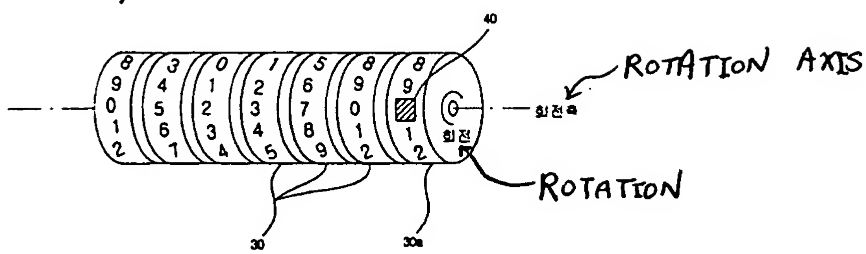


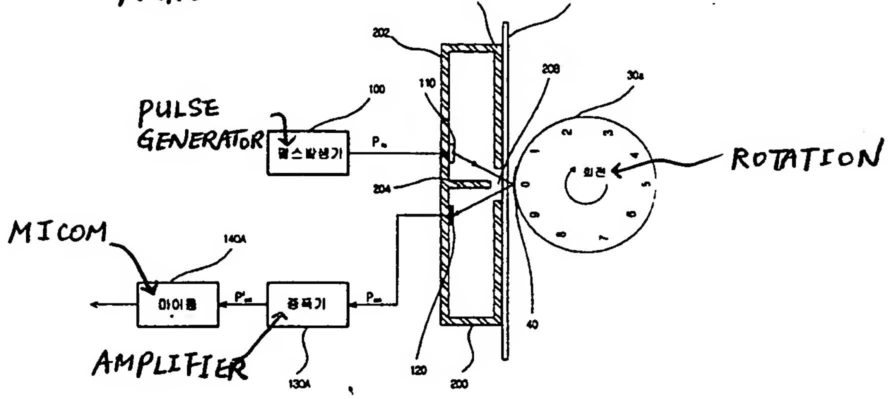
FIG. 1



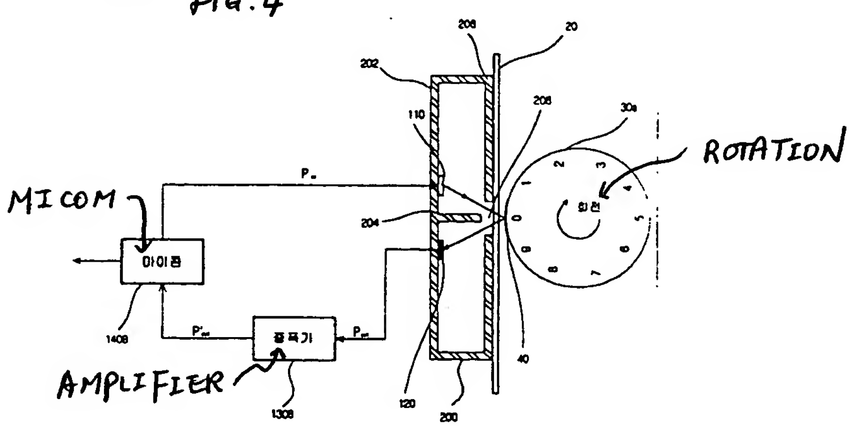
도면2 FIG. 2



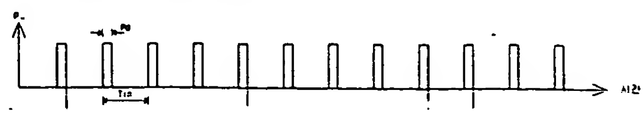
도면3
FIG. 3



도면4 FIG. 4



도면5a FIG. 5a



도면5b